# Tiva Based Daughter Board for Firebird V Hardware And Software Manual.

**eRTS Lab IIT Bombay**

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# 1 Credits

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# 2 Notice

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# 3 Introduction

# 4 Tiva Based Daughter Board

There are two daughter boards one with the launchpad and other one with the Arm Cortex M4 based uC. Almost all the specification are same unless mentioned otherwise.

## 4.1 Technical Specification

**Microcontroller:**
TM4C123gh6pm (ARM architecture based Microcontroller)
To know more about the microcontroller please refer to datasheet.

**Sensors:**
Three white line sensors (extendable to 7)
Five Sharp GP2Y0A02YK IR range sensor (One in default configuration)
Eight analog IR proximity sensors
Two position encoders

**Indicators:**
2 x 16 Characters LCD
Buzzer

**Communication:**
USB Communication
Wireless ZigBee Communication (2.4GHZ) (if XBee wireless module is installed)
Bluetooth communication(Can be interfaced on external UART0 available on the board)
Simplex infrared communication (From infrared remote to robot)
I2C Communication

**Battery Life:**
2 Hours, while motors are operational at 75% of time

**Locomotion:**
Two DC geared motors in differential drive configuration and caster wheel at front as support
Top Speed: 24 cm / second
Wheel Diameter: 51mm
Position encoder: 30 pulses per revolution
Position encoder resolution: 5.44 mm

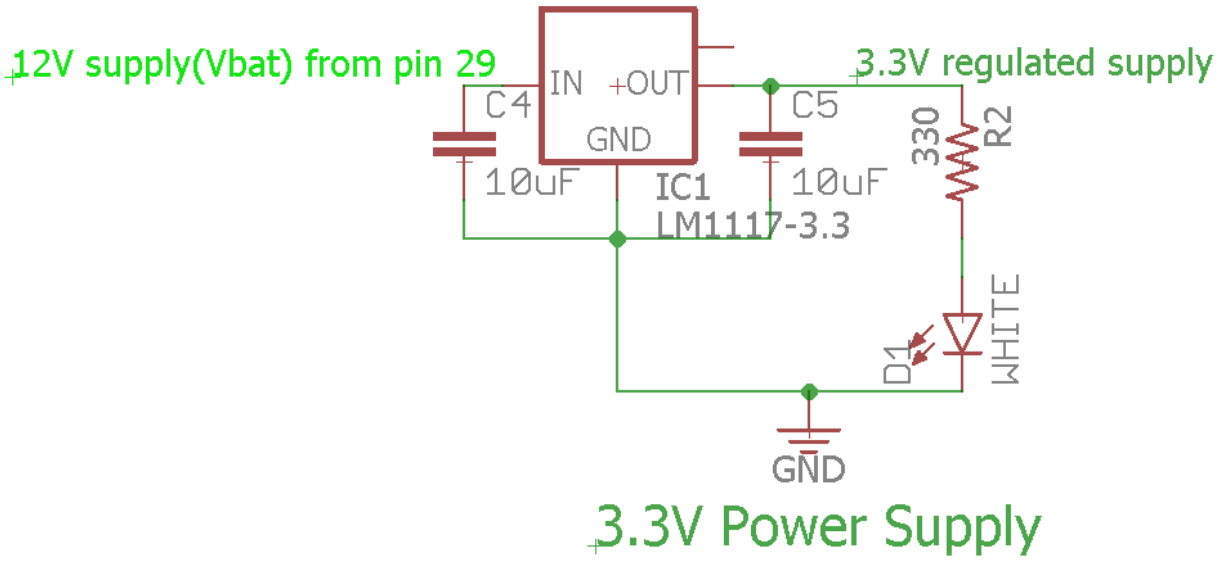
# 5 Hardware Manual:

## 5.1 Voltage Regulation on the Daughter Board

The voltage source available on the Firebird is 9.6V. But the TIVA platform works on 3.3V and the servos can operate upto 6V. So there must be 3 different voltage levels on the board. The uC based board has 2 voltage regulators and the plug and play board has 1 voltage regulator. In the uC based board the 9.6 volts is 3.3V to power the microcontroller. In the plug and play board the there is an inbuilt voltage regulator, so it is directly connected connected to 5v, 300mA source. The servo in both the boards has a separate 5V regulator.

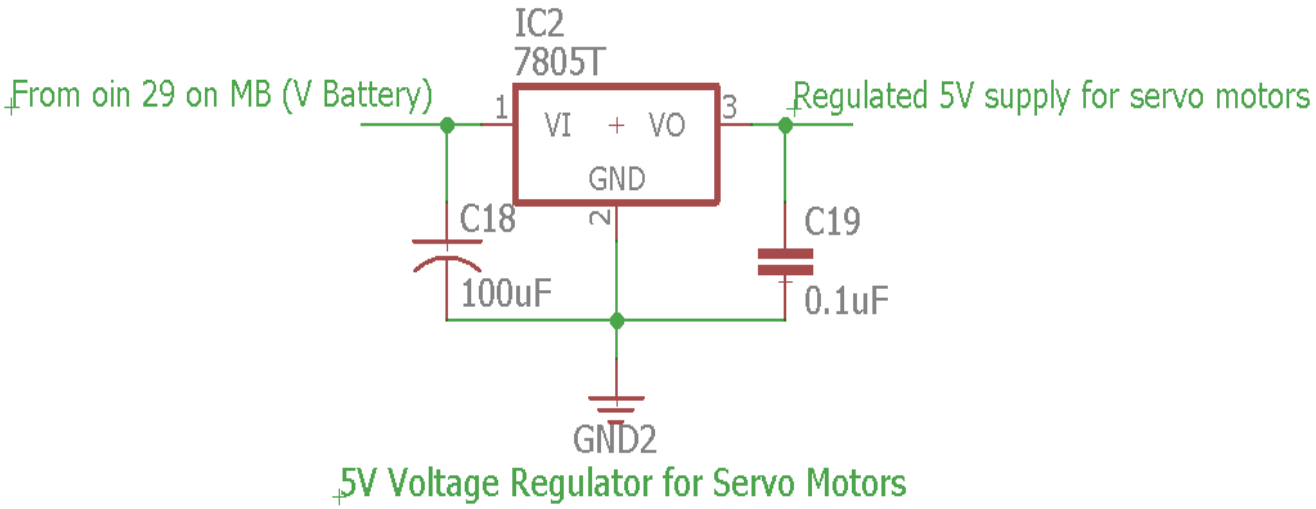
### 5.1.1 Powering Micro-controller

The boards have different powering circuits.In the plug and play board is connected to 5V source on Pin 10. In the uC based board the 9.6V source available on Pin 29 is reduced to 3.3V. Refer to the schematic below for further details.



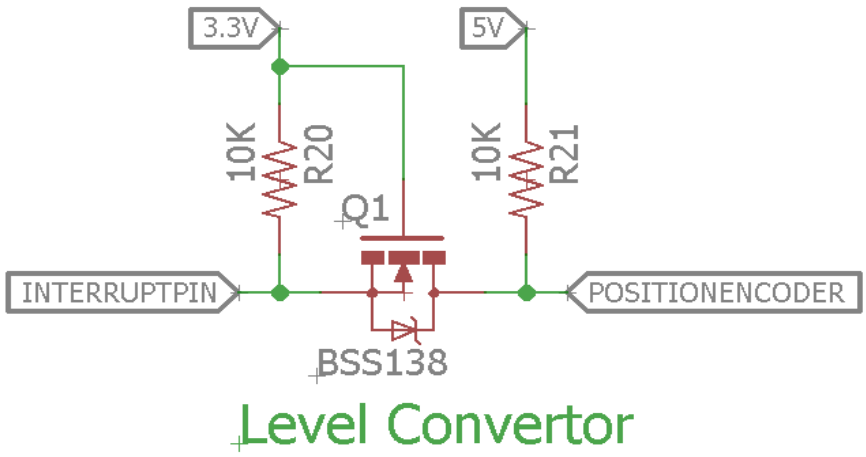

### 5.1.2 Powering Servos

The servo motors can operate safely up to 6V, beyond this voltage they get damaged. Also, the servos require high current. There is a separate power line for servos taken from Pin 29 and reduced to 5V using the voltage regulator. Refer the schematic for further details.




## 5.2 Level Converters

The TIVA platform operates at 3.3V and the Firebird operates at 5V. Directly connecting these pins to the TIVA may be fatal. So to interface these sensors, a level converter is used. A bidirectional MOSFET based level converter used. The level converter is necessary is for input pins. In the boards Level converter is used for interfacing the position encoders of the motors. Refer the schematic for further details.




**NOTE: If the user wishes to interface extra sensors using the GPIOs provided on the board, then external level converters have to used if the output of the sensor is above 3.3V.**

## 5.3 Sensors

### 5.3.1 3.3V sensors

The output white line sensors and IR Proximity sensors vary from 0 to 3.3V. Hence these sensors can be interfaced directly with the microcontroller. Refer the table below for pin connections.

### 5.3.2 5V sensors

## 5.4 Port Expander

## 5.5 External ADC

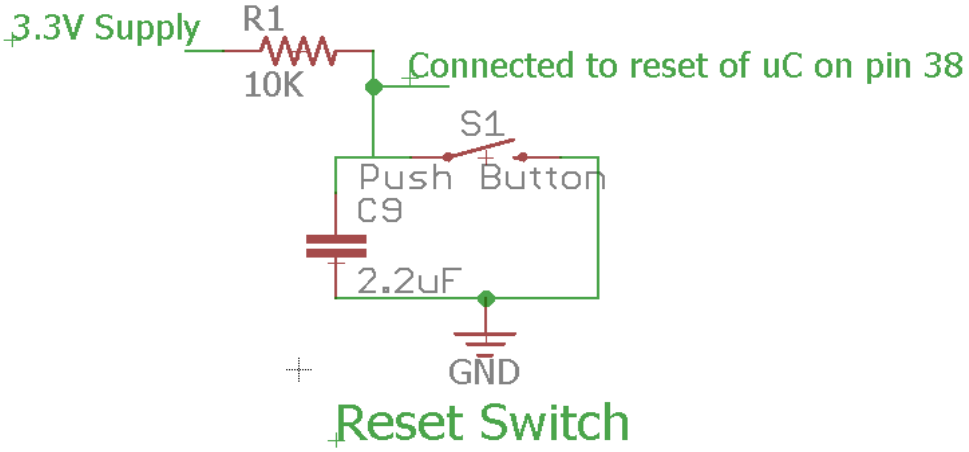
## 5.6 LCD Interfacing

## 5.7 Serial Communication

## 5.8 Programing the Controller

## 5.9 Reset Switch

The Plug and play board makes use of reset button present on the TIVA launchpad. The uC based has a switch connected to the reset the reset pin 38 of the microcontroller. The schematic is given below.




## 5.10 Pin Functionality

# 6 Software Manual:

## 6.1 Code Composer Studio:

Code Composer Studio is an integrated development environment (IDE) that supports TI's Microcontroller and Embedded Processors portfolio. Code Composer Studio comprises a suite of tools used to develop and debug embedded applications. It includes an optimizing C/C++ compiler, source code editor, project build environment, debugger, profiler, and many other features. The intuitive IDE provides a single user interface taking you through each step of the application development flow. Familiar tools and interfaces allow users to get started faster than ever before. Code Composer Studio combines the advantages of the Eclipse software framework with advanced embedded debug capabilities from TI resulting in a compelling feature-rich development environment for embedded developers. This description is directly taken from the website of Texas Instruments and click to know more about CC Studio

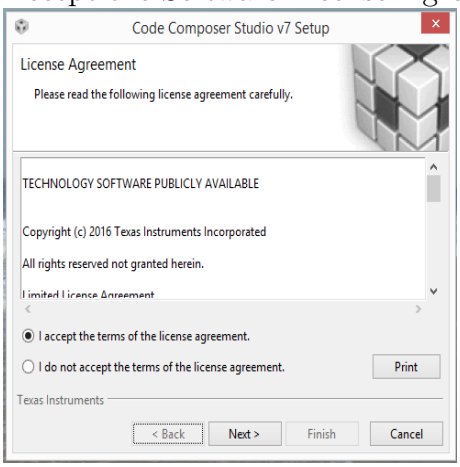
### 6.1.1 Download CC Studio:

At the time of writing this document Version 7 was the latest one. You can check for the latest at Download CCS.(do not download any beta versions).There will be two installer files.The web installer will require Internet access until it completes. If the web installer version is unavailable or you can't get it to work, download, unzip and run the offline version. The offline download will be much larger than the installed size of CCS since it includes all the possible supported hardware.

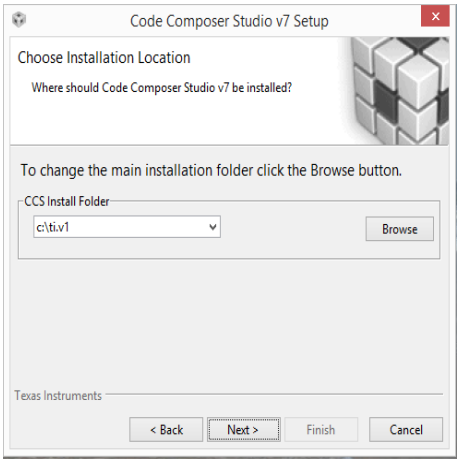
### 6.1.2 Installing C C Studio:

After the installer has started follow the steps mentioned below:

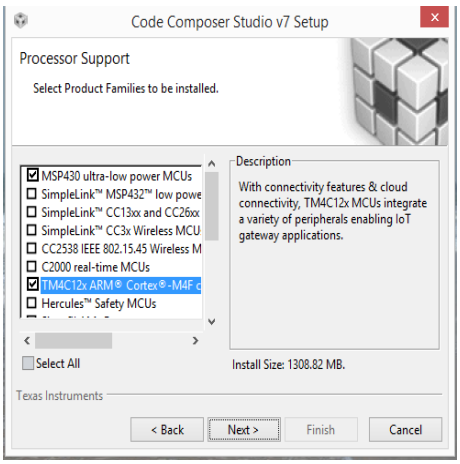
1. Accept the Software License Agreement and click Next.



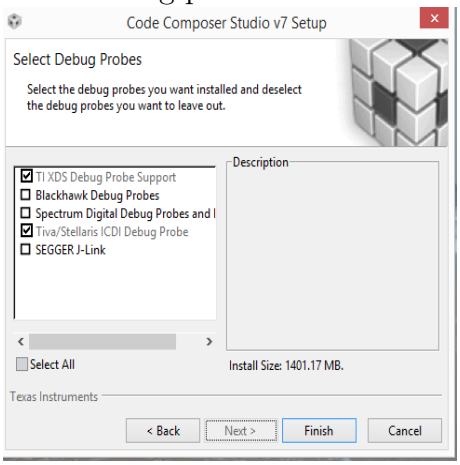

2. Select the destination folder and click next.




3. Select the processors that your CCS installation will support. You must select "TM4C12X Arm Cortex M4". You can select other architectures, but the installation time and size will increase.




4. Select debug probes and click finish




5. The installer process should take 15 - 30 minutes, depending on the speed of your connection. The offline installation should take 10 to 15 minutes. When the installation is complete, uncheck the "Launch Code Composer Studio v7" checkbox and then click Finish.There are several additional tools that require installation during the CCS install process. Click "Yes" or "OK" to proceed when these appear.

6. Install TivaWare for C Series (Complete). Download and install the latest full version of TivaWare from: TivaWare. The filename is SW-TM4C-x.x.exe . This workshop was built using version 1.1. Your version may be a later one. If at all possible, please install TivaWare into the default location.

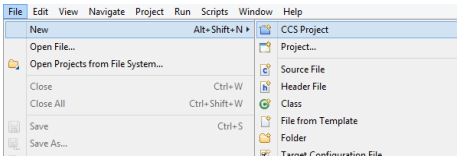
**You can find additional information at these websites:**
Main page: www.ti.com/launchpad
Tiva C Series TM4C123G LaunchPad:
http://www.ti.com/tool/ek-tm4c123gxl
TM4C123GH6PM folder:
http://www.ti.com/product/tm4c123gh6pm
BoosterPack webpage: www.ti.com/boosterpack
LaunchPad Wiki:
www.ti.com/launchpadwiki

For understanding the launchpad properly and to learn more about Tiva it is strongly recommended to go through the webpage TIva Worshops and download and read the workbook

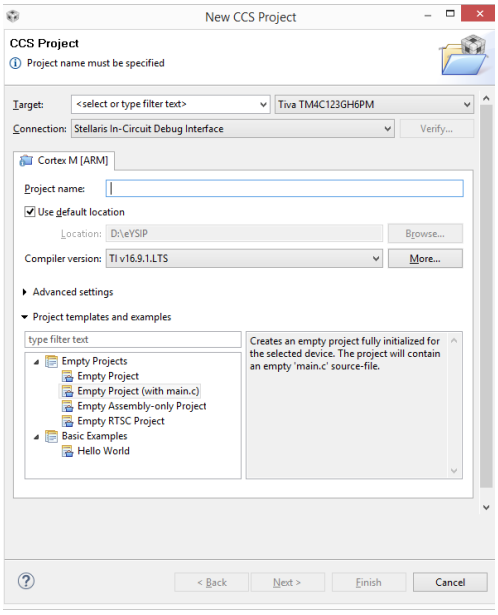
### 6.1.3 Create a New Project

To create new project follow the steps mentioned:

1. Click File then New and then CCS Projects




2. Select Target and connection as shown in the photo. Give a name to your project and save in a location.Click Finish. A main.c file will be open




### 6.1.4 Add Path and Build Variables

The path and build variables are used for:

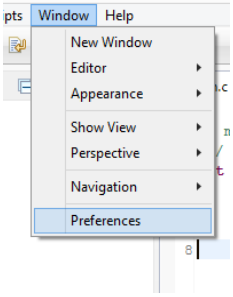
- Path variable – when you ADD (link) a file to your project, you can specify a "relative to" path. The default is PROJECT_LOC which means that your linked resource (like a .lib file) will be linked relative to your project directory.
- Build variable – used for items such as the search path for include files associated with a library – i.e. it is used when you build your project.

Variables can either have a PROJECT scope (that they only work for this project) or a WORKSPACE scope (that they work across all projects in the workspace). In the next step, we need to add (link) a library file and then add a search path for include files. First, we'll add these variables MANUALLY as WORKSPACE variables so that any project in your workspace can use the variables. Refer to the workbook by TI for adding as PROJECT

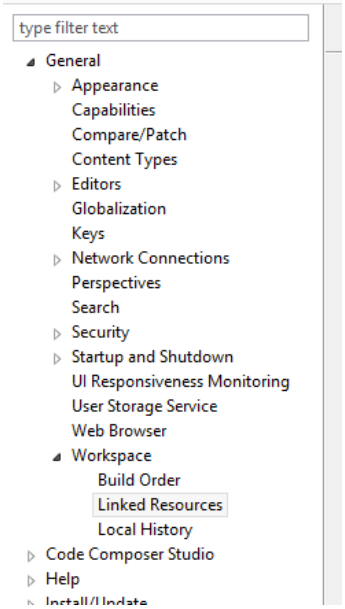
#### 6.1.4.1 Adding a Path Variable

To add a path variable,:

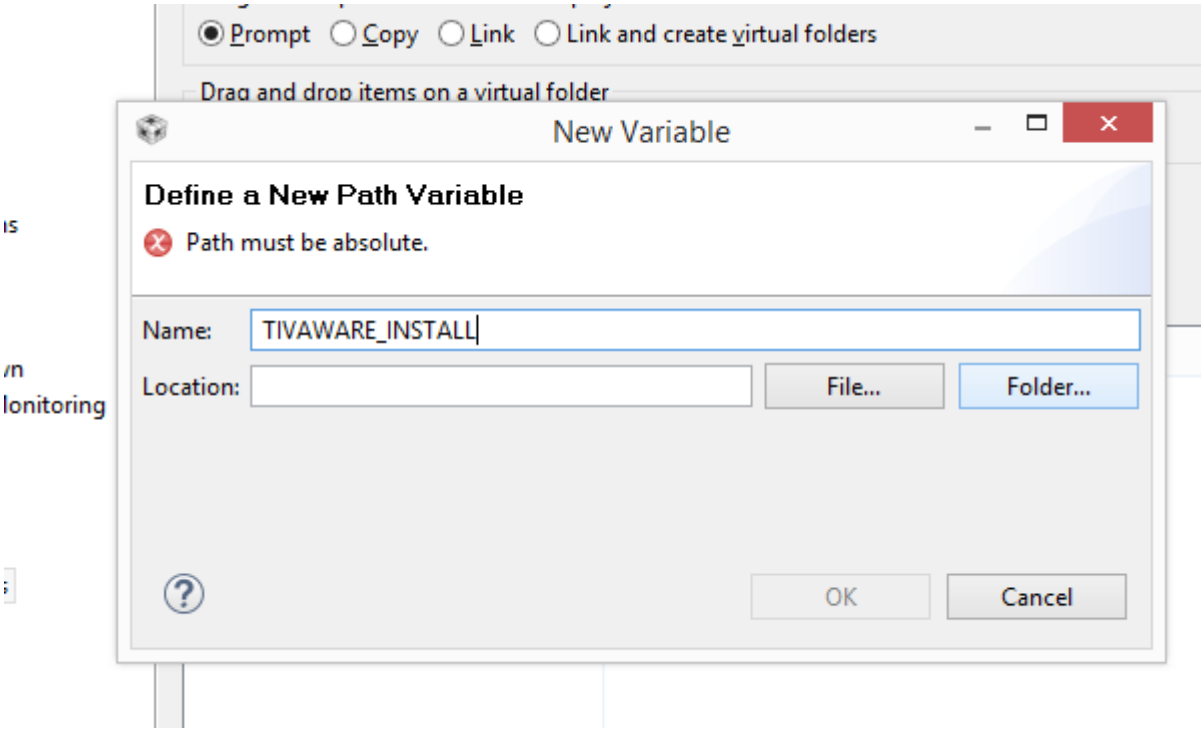
- Right-click on your Window Tab and select Preference.



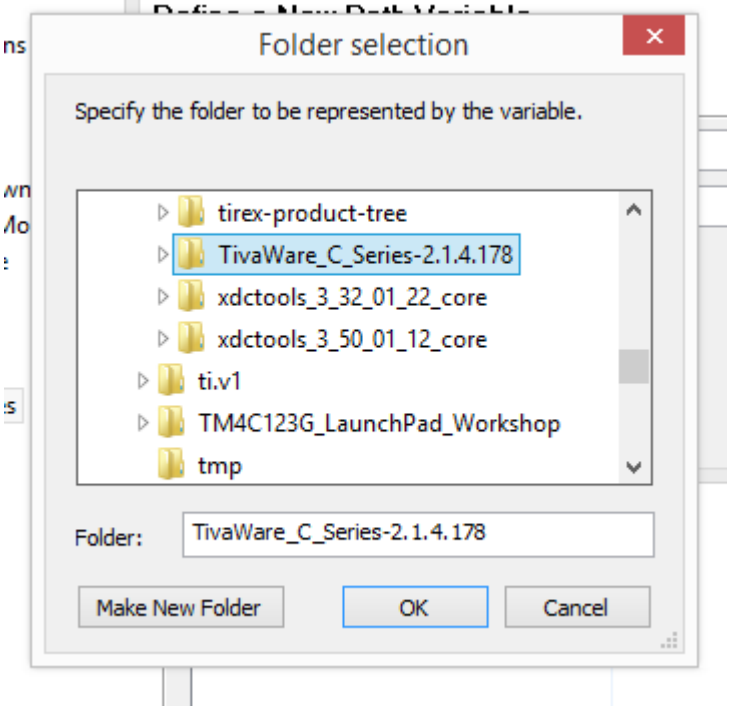

- Expand General list in the upper left-hand corner as shown and then expand the Resource list and click on Linked Resources: We want to add a New variable to specify exactly where you installed TivaWare.

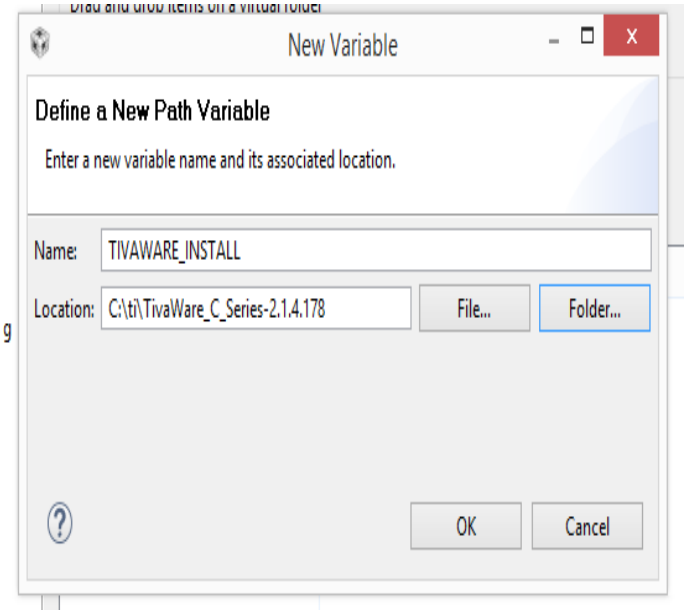



- Click New
- When the New Variable dialog appears, type TIVAWARE_INSTALL for the name.

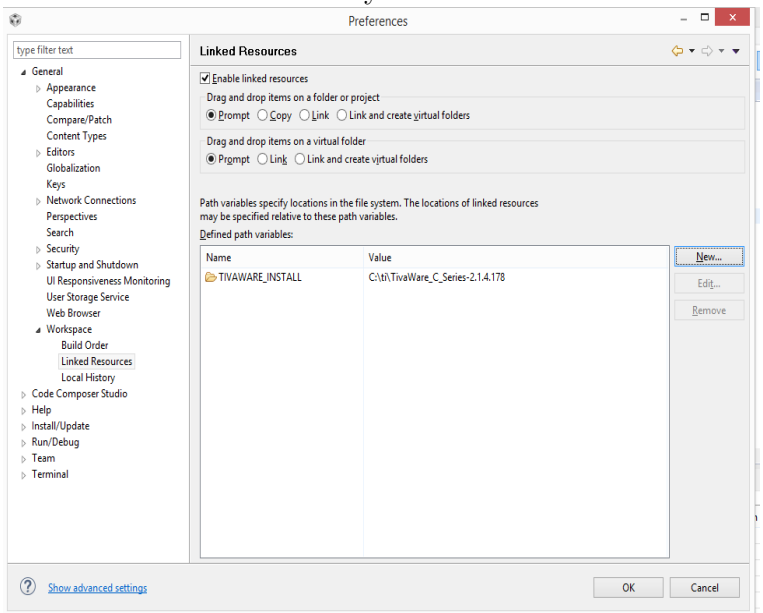



- For the Location, click the Folder... button and navigate to your TivaWare installation. Click on the folder name and then click OK.





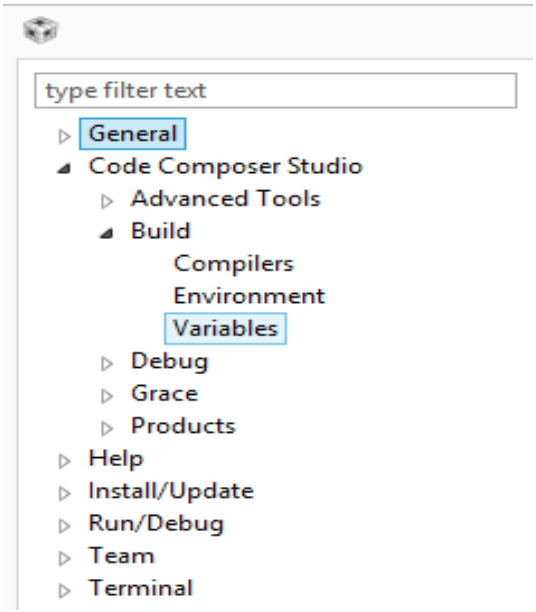

- Click OK. You should see your new variable listed in the Variables list.




### 6.1.4.2 Adding a Build Variable

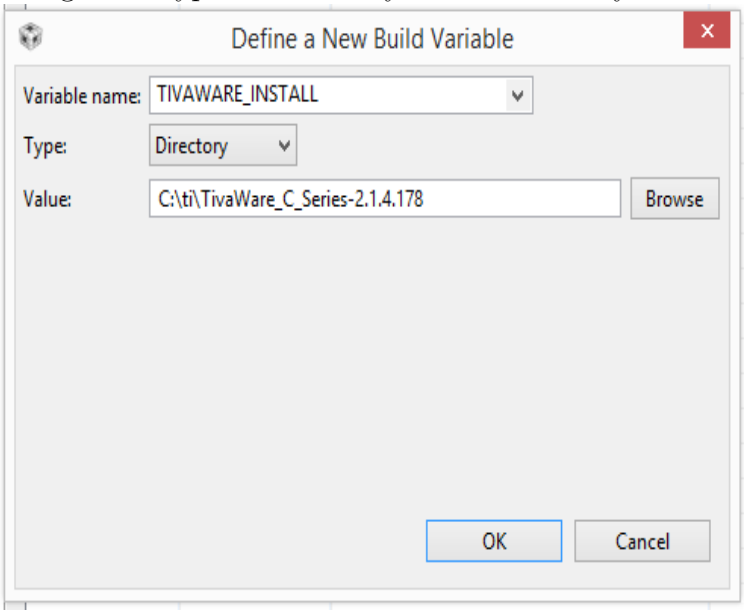
Now let's add a build variable that we will use in the include search path for the INCLUDE files associated with the TivaWare driver libraries.

- Click on Code Composer Studio Build and then the Variables tab:

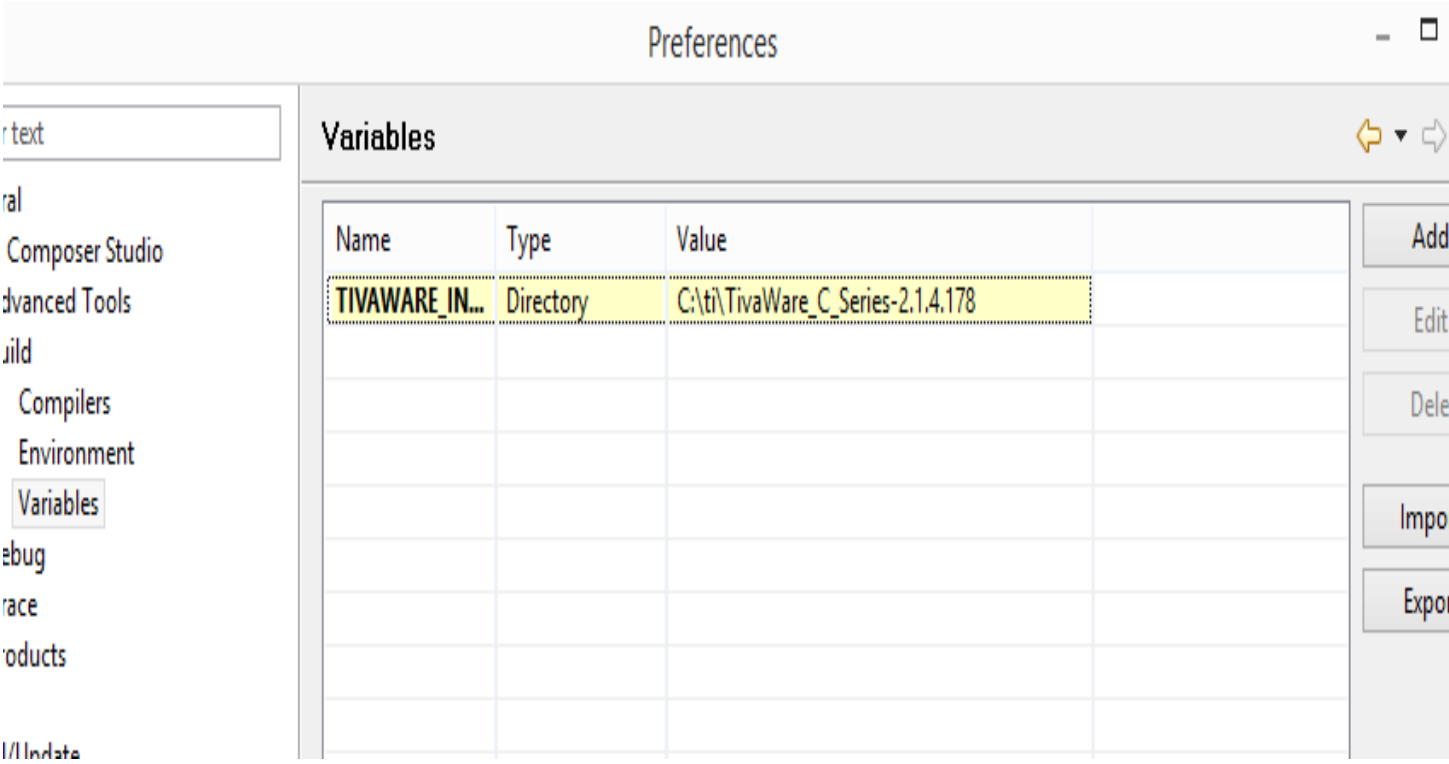



- Click the Add button. When the Define a New Build Variable dialog appears, insert TIVAWARE_INSTALL into the Variables name box.

- Change the Type to Directory and browse to your Tivaware installation folder.




- Click OK.
- Click OK again to save and close the Build Properties window.




## 6.2 driver.lib

## 6.3 Buzzer

Located in the folder "Buzzer_Beep" folder in the documentation. In this example, we will load buzzer beep code in Tiva based Fire Bird V. Now we will see in detail the structure of this code.This experiment demonstrates the simple operation of Buzzer ON/OFF with one some delay. Buzzer is connected to PORTF 4 pin of the Tiva Launchpad. If you have uC based board then it is connected to PORTA 2. Concepts covered: Output operation, generating delay Note: Make sure that you have included driver.lib // Buzzer is connected at PF4/PA2 on Tiva launchPad/uC // To turn it on make PF4/PA2 pin logic 1